Production of Quality Apple Butter With Good Yield

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APPLE butter has long been a favorite spread for both children and adults. The wartime emphasis placed on spreads as a means of increasing bread consumption as well as the desirability of obtaining the most value from the apple crop suggested an investigation of methods for obtaining good yields of apple butter without sacrifice of quality.

Commercial apple butter varies in quality and differs markedly from the home-made product. It is composed of cooked apple pulp and sugar, to which may be added a small amount of cider, and spices. Most commercial products are what may be called "sauce type" butters. The proportion of boiled cider to fruit is small, and the butters are concentrated to just above the minimum Federal standard of 43 per cent soluble solids. Thus the consistency is relatively thin, and the tart flavor of a cider butter is lacking.[2]

"Old-fashioned Pennsylvania Dutch" apple butter closely resembles the home-made product. It is a dark-brown, tart, full-flavored spread of almost solid consistency. This butter is usually made in small plants with simple equipment. Whole apples are put into a wooden barrel, covered with water, and cooked by means of a copper steam coil. When soft enough to yield a sauce the apples are sieved, usually by hand. At the same time boiled cider of varying concentration, depending on the desire of the operator, is prepared by open-pan evaporation of apple juice. The sauce and boiled cider are blended in amounts depending again on the whims of the operator, and the mixture is boiled down. Sometimes sugar is added; often it is not. Cooking is continued until a spoonful placed upon a cold plate will cling when the plate is inverted. Spices, if used, are added during the last 5 or 10 minutes of cooking.

In this old-fashioned product the ratio of boiled cider to fruit is high, perhaps 6 to 1 on a fruit weight basis, that is 5 to 7 bushels of apples used for boiled cider to 1 bushel of apples used for sauce. The screening is usually inefficient, being time consuming and resulting in 15 to 20 per cent waste. Also the time of cooking is long, since concentration by this method is slow. And most important, the yield per bushel, 2 to 3 quarts, is so low as to require a higher selling price for this type than for the "sauce" type.

The studies reported herein had as their object the production of an apple butter approaching the old-fashioned Pennsylvania Dutch apple butter in quality and at the same time with a yield more competitive with that of commercial apple butters. This was accomplished by increasing the fruit-to-cider ratio and by allowing oxidative browning to darken the pulp before cooking. Suggestions are made for standardizing quality, and more efficient methods are introduced.

General Procedure

Boiled Cider—Whole, sound, washed apples were grated and pressed in a hydraulic cider press. The juice was transferred to a steam-jacketed, stainless-steel kettle equipped with mechanically driven paddles. Here it was first agitated at 115°-120° F. (46°-49° C.) for 10 to 15 minutes, and then evaporated at atmospheric pressure without stirring and with about 25 pounds of steam pressure in the jacket. When concentrated to 33 to 35 per cent soluble solids, as determined by a refractometer, the boiled cider was removed and stored for later use.

Sauce—Sorted, washed apples were ground by a rotary knife grater. The ground pulp was transferred to a steam-jacketed kettle equipped with an overhead agitator. For each bushel of apples used, 1½ to 2 gallons of water or cider was added, and the pulp was then agitated for 15 to 20 minutes at 115°-120° F. to bring about enzymic oxidation. After this, lids were placed on the kettle, and the fruit was cooked, with constant mixing, at 20 to 25 pounds steam pressure in the jacket for about 15 minutes. The soluble solids of the cooked pulp ranged from 15 to 18 per cent, as determined by a refractometer. The pulp was then run through a paddle pulper equipped with a screen having 0.060-inch perforations.

Cooking the Butter—The amounts of the various ingredients were calculated, and half the sauce, half the boiled cider, and all the sugar were put in the steam-jacketed kettle at the start of cooking. A steam pressure of 25 to 30 pounds was used, and the agitator was run constantly. The butter was concentrated to a soluble solids content of 70 to 75 per cent, at which stage the second half of the sauce was added. The butter was reconcentrated to about 58 per cent solids, and then the

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[2] Campbell, C. H., Campbell's Book—Canning, Preserving, and Pickling, 357-360, Vance Publishing Corp. (1937).

second half of the boiled cider was added. If spices were to be used, they were added at this time. Cooking was continued for a few minutes longer, until the finished apple butter had a soluble solids content of 50 to 53 per cent. The hot, finished butter was run into warm, quart glass jars, which were sealed and then pasteurized in hot water at 190°-195° F. (88°-91° C.) for 25 to 30 minutes.

Details of Procedure

BY GRINDING the apples a greater surface of pulp could be exposed to the air during agitation to produce oxidative darkening. Moreover, when made from ground apples, the finished butter showed more body at a given solids content than one made from whole apples. This is attributed to a possible increased extraction of pectin during the oxidation period.

The purpose of adding 1½ to 2 gallons of water or cider to pulp from a bushel of apples was threefold. First, the more liquid pulp was better oxidized. Second, it aided in cooking the pulp to a desirable consistency. And third, the pulp was fluid enough to be tapped off and screened satisfactorily. Since the amount of liquid required varied with the variety and condition of the apples used, the amount specified is merely an average.

Agitation of the cider and of the raw ground pulp produced darkening by air oxidation. The oxidation was much more rapid at 115°-120° F. than at room temperature. Although continued agitation up to 60 minutes produced further darkening, a practical maximum was reached within 15 to 20 minutes. Other tests proved that the darkening was due to enzymic oxidation rather than pure chemical action. Thus, if the raw ground pulp was cooked immediately, little darkening resulted from agitation thereafter. For this reason the temperature of oxidation was not raised above 120° F.

In our experiments a screen with 0.060-inch perforations was used with a paddle pulper. By a single passage of the pulp through the pulper, the loss (seeds, skins, and cores) ranged from 5.0 to 5.5 per cent by weight on the basis of the original fruit. This loss appeared to be the practical minimum under the operating conditions. By using an 0.045-inch screen a much smoother sauce could be produced, with but a slight increase in waste.

A few tests were made in which the uncooked ground pulp was put through the paddle finisher. Addition of 1½ to 2 gallons of water or cider per bushel of apples aided pulping. The waste, however, amounted to about 14 per cent. By repassage of this waste through the finisher, the loss was lowered to about 18 per cent. The sauce, however, was no browner than that obtained by oxidation before pulping, and the process put a heavy load on the pulper.

To develop color and flavor by means of slight caramelization, the apple butter was overcooked to a high concentration of solids. To help compensate for this high cencentration the boiled cider was evaporated to only 33 to 35 per cent soluble solids instead of the usual 58 to 60 per cent in commercial boiled ciders. This cider of lower concentration was used for thinning the overconcentrated butter in order to obtain the desired solids content in the finished product.

No study was made of the use of spices, since every manufacturer prefers his own selection. Campbell[3] has discussed this phase rather fully.

Formula Calculations

TO ESTABLISH a standard basis for apple butter, the Food and Drug Administration has set up regulations governing its composition and manufacture when entering inter-state commerce. These may be found under Docket No. F.D.C.-10-C in the Federal Register of September 5, 1940, Vol. 5, No. 173, p. 3561-3564.[4] The rather complicated statement may be reduced to the following: For every part, by weight, of sugar a minimum of 2.5 parts by weight of sauce is necessary. If cider is used its weight must be at least one-half the weight of the sauce, in which case sugar is not required. Thus to 2.5 parts by weight of sauce a minimum of 1.25 parts by weight of cider is necessary. The finished butter must contain not less than 43 per cent soluble solids.

The parts by weight are not based on the actual weights of the ingredients but on their weights calculated as prescribed by the Federal Standards, which take into consideration the solids content of each ingredient; and in the case of either the sauce and/or boiled cider, the average percentage of soluble solids in the original apples. The Federal Standards (F.S.) weights may be determined as follows.

The F.S. weight of the sugar, or optional saccharine ingredient, means the weight of the solids of this constituent. For sugar this is its actual weight. By sauce is meant the original fruit minus its skins, seeds, and cores. If any sugar or cider was added to the fruit during its processing into sauce the weight of the solids of this added ingredient must be subtracted from the weight of the sauce. Thus the F.S. weight of the sauce may be calculated as follows:

> F.S. weight of sauce = 7.5 [(actual weight of sauce) (per cent solids of sauce)—(actual weight added ingredient) (per cent solids of ingredient)].

If, in making the sauce, no other ingredient was added, the subtracted portion of this formula becomes zero. The value 7.5 is the fruit factor, which is specific for apples and is based on an assumed average soluble solids content of 13.7 per cent.

The F.S. weight of the cider, either dilute or concentrated, may be calculated as follows:

> F.S. weight of cider = 7.5 (actual weight of cider) (percent soluble solids of cider).

Our formulas for apple butter are expressed as weight ratios of the ingredients calculated as described above according to the Federal Standards. Formulas for the best butters varied somewhat, depending on the variety and condition of the apples used. In general, good butters

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[3] Campbell, C. H., Canning Age 17, 453-54; 504 (1936).

[4] This may be obtained from local city or State Food and Drug offices or from the Food and Drug Administration, Washington 25, D. C.

were produced with a F.S. weight ratio of sugar to sauce of 1.0 to 6.0. To this was added between 5.5 and 6.0 parts by F.S. weight of boiled cider. Yields were calculated on the basis of the total apples used in making both the sauce and the boiled cider. The weight of sugar used per bushel of fruit ranged from 3.5 to 4.0 pounds. The per cent soluble solids was determined with a refractometer, a sucrose scale being used. A sample calculation of formula and yield is given in Table I.

TABLE I

Sample Calculation of Formula and Yield

Ingredient	Actual weight, lbs.	Solids, %	F. S. weight, lbs.	Parts by F. S. weight	Apples, bu.
Sugar	19.9	100.0	19.9	100	
Sauce	97.5	16.4	120.0	603	2.53
Boiled cider	44.7	35.3	118.2	594	2.61
Total					5.14

Finished butter—45 quarts of 51.7% solids
Yield—8.8 quarts per bushel

In overcooking to a high concentration of soluble solids, it is desirable for close control to know the maximum concentration to which the butter may be reduced before the addition of the second half of the boiled cider in order to produce a finished butter of the desired solids content. This may be determined by the following calculation based on the equation:

$$\text{Percent solids in concentrated butter} = \frac{\text{weight of solids in concentrated butter}}{\text{weight of concentrated butter}} \times 100 \quad (1)$$

The weight of solids in the concentrated butter is found as follows, using the sample formula given in Table I:

Weight of sauce x percent solids of sauce, 97.5 x 0.164	=	16.0
Weight of half of cider x percent solids of cider, ½ x 44.7 x 0.353	=	8.1
Weight of sugar	=	19.9
Weight of solids in concentrated butter	=	45.0

The total weight of concentrated butter must not be more than equal to that of the finished butter less half the cider; otherwise water in addition to half the cider will have to be added to reduce the cider to the desired concentration.

$$\text{Total weight of finished butter} = \frac{\text{weight of solids in finished butter}}{\text{desired percent solids in finished butter}} \quad (2)$$

The total weight of solids in the finished butter is the sum of the weight of each of the various ingredients multiplied by the per cent solids of that ingredient.

Weight of sauce x percent solids of sauce, 97.5 x 0.164	=	16.0
Weight of cider x percent solids of cider, 44.7 x 0.353	=	16.0
Weight of sugar x percent solids of sugar, 19.9 x 1.00	=	19.9
Total weight of solids in finished butter	=	52.0

Dividing this total weight of 52.0 pounds by the desired per cent solids in the finished butter, 51.7 per cent, we find from equation (2) $\frac{52.0}{0.517} = 100.6$ pounds to be the total weight of the finished butter of 51.7 per cent solids. Now, subtracting the weight of half the cider, 22.4 pounds, we find the weight of the concentrated butter to be 100.6—22.4=78.2 pounds.

Substituting in equation (1), we find the per cent solids in the concentrated butter $= \frac{45.0}{78.2} \times 100 = 57.5$ per cent.

The concentrated butter can therefore be taken to 57.5 per cent solids before the remaining half of the cider is added, whereupon the finished butter will have the desired solids content of 51.7 per cent. It must be remembered that this is the theoretical maximum concentration to which the concentrated butter can be taken if the finished butter is to have the desired solids content. It does not take into consideration concentration effected during the necessary boiling after the addition of the last half of the cider. In practice it will be necessary to stop a few per cent short of the maximum, add the remaining cider, and then cook to the desired solids content.

Although this calculation is lengthy, it is helpful during the first few runs when the process is being established. After the plant capacity has been determined and the percentage solids of the ingredients decided upon, most of the factors become practically constant.

Variety of Apples

APPLE butter was made from four varieties of apples: Stayman Winesap, Jonathan, Grimes Golden, and Rome Beauty. All produced satisfactory butters, but the first two were preferable because of better flavor and high acidity. A minimum acidity of about 0.65 per cent in the finished butter was necessary to impart a tart apple taste. Acidities were determined by electrometric titrations with standard alkali, and calculated as per cent malic acid by weight.

Apple Chops

SINCE considerable apple butter is made from apple chops, it was thought worth while to investigate the feasibility of using them in connection with the process described here. The chops were allowed to soak for 16 hours (overnight) in five times their weight of water. They were then ground and agitated at 115°-120° F. (46°-49° C.) in the same manner as were the fresh apples. Browning of the pulp was not produced from the chops by this treatment. The lack of color development was probably due to changes produced in the apples during sulfuring and drying. Consequently, when making apple butter from chops this quick method of darkening the pulp would not be applicable, and treatments requiring more time would have to be used.

Conclusion

A TART, full-flavored apple butter of rich-brown color and smooth semi-solid consistency can be produced by using a weight ratio of sugar: sauce: boiled cider of

1 : 6 : 6, calculated according to Federal Standards methods, and by cooking to a final concentration of 50 to 53 per cent soluble solids. A yield of 8 to 9 quarts of apple butter per bushel of apples is obtained, and the time of cooking is reduced to approximately one-third that required by the "old-fashioned Pennsylvania Dutch" method.

A darkened sauce for the butter can be obtained by grinding the apples and agitating the ground raw pulp. During this oxidative browning, conditions are possibly more favorable for the extraction of pectins, which would account for the better "body" of the finished butter. A desirable dark color and caramelized flavor can be quickly developed by overcooking the butter to a high concentration and then thinning to the final concentration with a portion of the sauce and cider reserved for this purpose.

Lists Best Tomatoes to Grow for Canning

JOHN Baer and Stokesdale lead all varieties grown for the canning factory both in yield and in acreage in New York State, says Professor W. T. Tapley, vegetable crops specialist at the State Experiment Station at Geneva, N. Y. The popularity of John Baer is further supported by its good quality when canned, its earliness, and for the red color of the juice.

Other good canning varieties with a ripening season similar to that of John Baer and also similar in plant and fruit characters are Coburg, Nystate, Bonny Best, and Landreth. Averaging the yields in tests conducted by the Station over a 5-year period, these varieties will produce about 4 tons of fruit to the acre up to September 1st, about 6 tons from September 1 to 10, and about 3 tons from September 10 to the end of the growing season. These yields may be expected when the crop is grown on well-drained soil, liberally fertilized. The plants of these varieties blossom early with many clusters setting fruit within a short period. The peak for mature ripe fruit comes during the first 10 days of September.

Stokesdale, despite some criticism of its lack of color, is rapidly gaining in importance because of the good yields, large vigorous plants, and heavy foliage cover, it is said. Stokesdale plants generally have green fruits at the end of the season, whereas John Baer plants will have ripened all of their fruits.

Rutgers produces fruit of good color, quality, and size, but it is a late-season variety. For this reason yields in tests at the Experiment Station have been from 3 to 5 tons to the acre lower than the cannery varieties mentioned above. "In tests of the past few seasons, there have been few new varieties that have tended to displace the old standard sorts," concludes Professor Tapley.